Announcements

- EXAM 2 will be returned at the END of *tomorrow*!
- Homework for tomorrow…

  Ch. 32: CQ 1, 4, & 5

- Office hours…

  MW 10-11 am
  TR 9-10 am
  F 12-1 pm

- Tutorial Learning Center (TLC) hours:

  MTWR 8-6 pm
  F 8-11 am, 2-5 pm
  Su 1-5 pm

Chapter 32

The Magnetic Field

(*Magnetism & The Discovery of the Magnetic Field*)

32.1: Magnetism

1. Magnetic poles and electric charges share *some* similar behavior, but they are NOT the same.

2. Magnetism is a *long range force*.

3. Magnets have 2 poles, N & S, & are thus *magnetic dipoles*.
   - Unlike charges, isolated N or S poles do NOT exist!

4. 2 *like* poles exert *repulsive forces* on each other,
   2 *opposite* poles exert *attractive forces* on each other.

5. Materials that are attracted to a magnet are called *magnetic materials*. (i.e.: iron)
   - Magnetic materials are attracted to *both* poles of a magnet.

Quiz Question 1

The north pole of a compass needle is attracted toward the geographic north pole of the earth. The earth is a big magnet!

The geographic north pole is:

1. a magnetic north pole, obviously.
2. in reality a magnetic south pole.

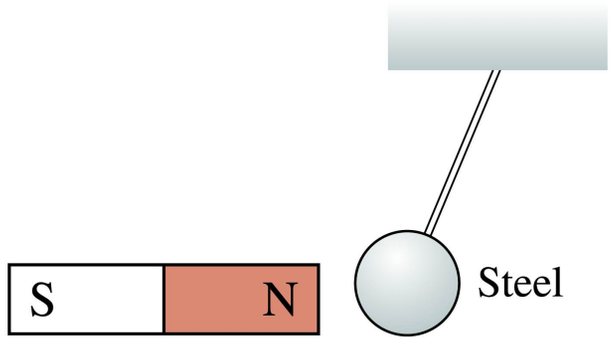
Compasses and Geomagnetism

Interesting facts:

- The *geographic north pole* is a *magnetic south pole*!
- The magnetic poles are slightly offset from the geographic poles of the earth's rotation.

Quiz Question 2

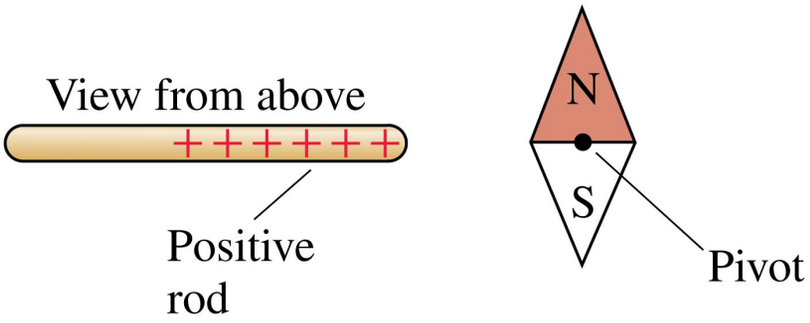
If the bar magnet is flipped over and the south pole is brought near the hanging ball, the ball will be



1. attracted to the magnet.
2. repelled by the magnet.
3. unaffected by the magnet.
4. I'm not sure.

Quiz Question 3

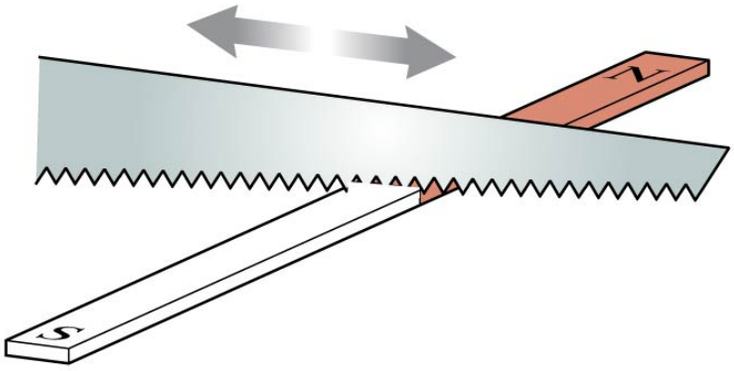
The compass needle can rotate on a pivot in a horizontal plane. If a positively charged rod is brought near, as shown, the compass needle will



1. rotate clockwise.
2. rotate counterclockwise.
3. do nothing.
4. I'm not sure.

Quiz Question 4

If a bar magnet is cut in half, you end up with



A. S N N S

B. N S S N

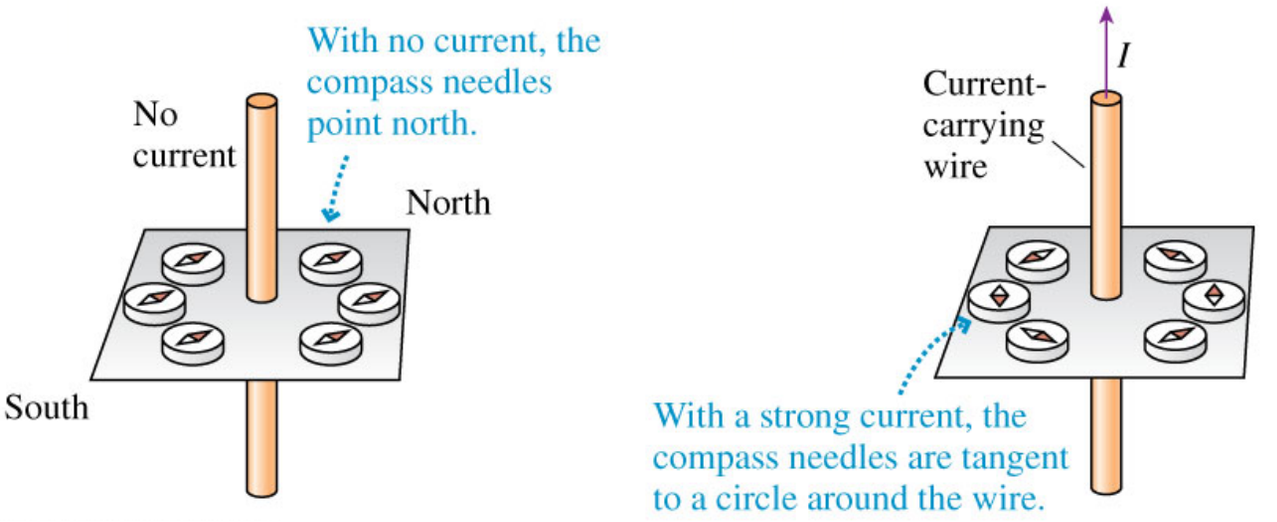
C. S N S N

D. S N

E. Unmagnetized

32.2: The Discovery of the Magnetic Field

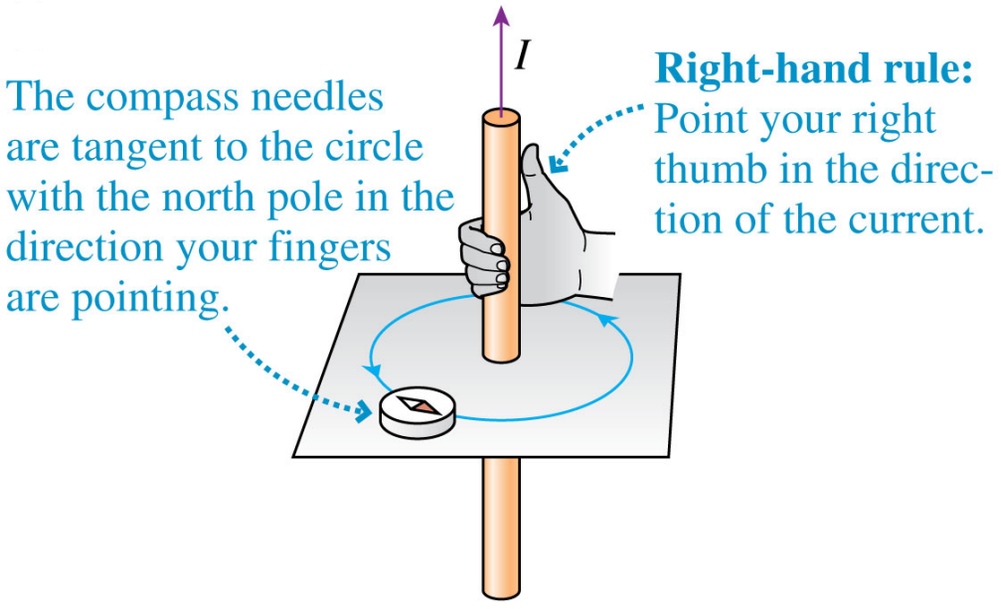
In 1819, Hans Christian Oersted discovered that an electric current in a wire causes a compass to turn.



- Oersted discovers that *magnetism* is caused by an *electric current*!

32.2: The Discovery of the Magnetic Field

The *right-hand rule* determines the *orientation* of the compass needle with respect to the *direction* of the current.

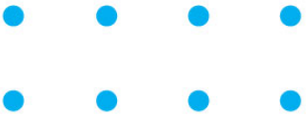


32.2:
The Discovery of the Magnetic Field

Magnetism requires a 3D perspective, but 2D figures are easier to draw.

Vectors into page

Current into page



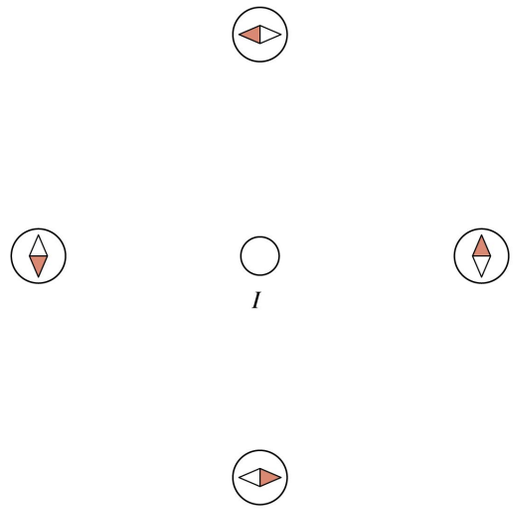
Vectors out of page

Current out of page

Quiz Question 5

A long, straight wire extends into and out of the screen.

The current in the wire is

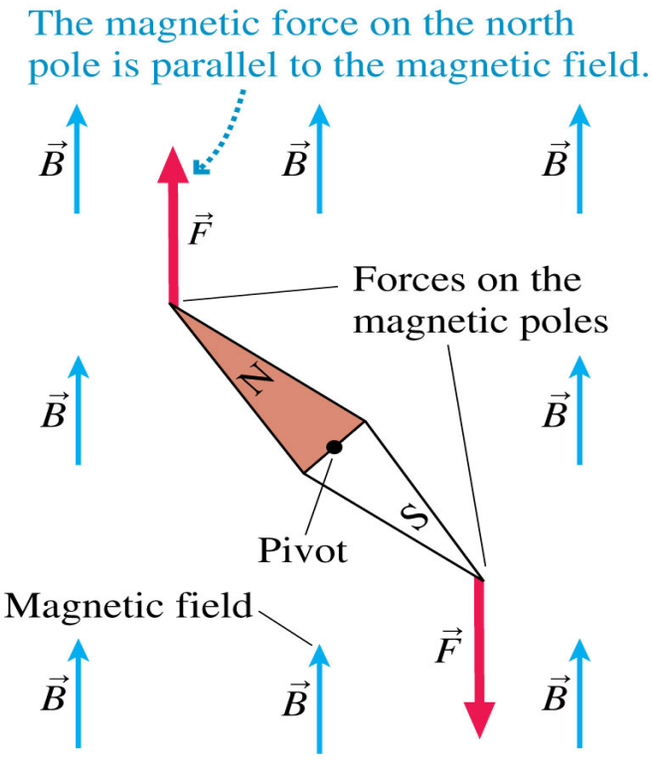


1. into the screen.
2. out of the screen.
3. there is no current in the wire.
4. not enough info to tell the direction.

The Magnetic Field

Define the magnetic field, $\vec{B}$, as having the following properties:

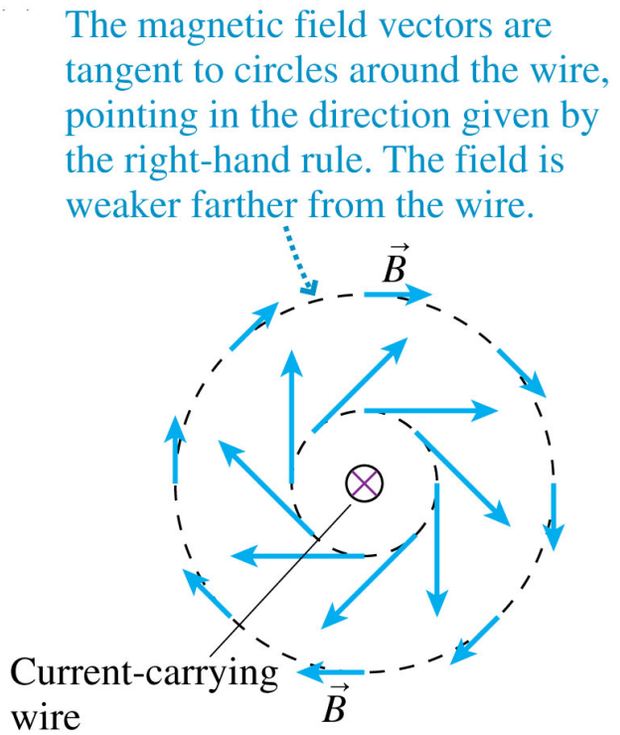
1. A magnetic field is created at *all* points in space surrounding a current-carrying wire.
2. The magnetic field at each point is a *vector*, with *magnitude* & *direction*.
   - Magnitude is the *magnetic field strength B*.
3. The magnetic field exerts *forces* on magnetic poles.
   - Force on north pole is *parallel* to *B*.
   - Force on south pole is *anti-parallel* to *B*.



The Magnetic Field

Notice:

The field is *weaker* at *greater distances* from the current-carrying wire.

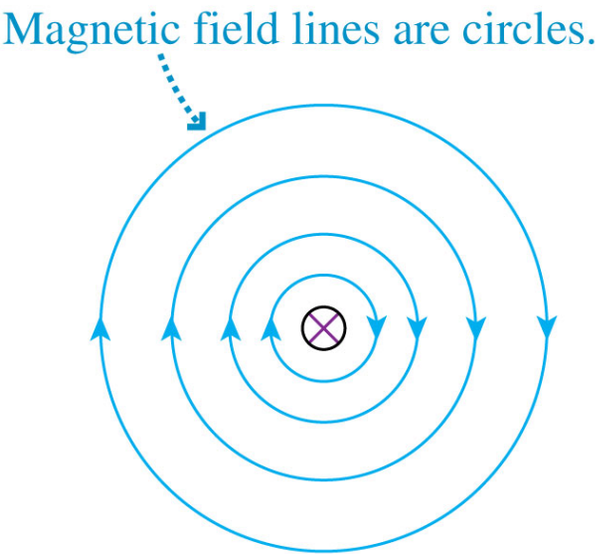


The Magnetic Field

Magnetic field lines…

are imaginary lines drawn through a region of space so that:

- A *tangent* to a field line is in the direction of the magnetic field.
- The field lines are *closer together* where the *magnetic field strength* is *larger*.



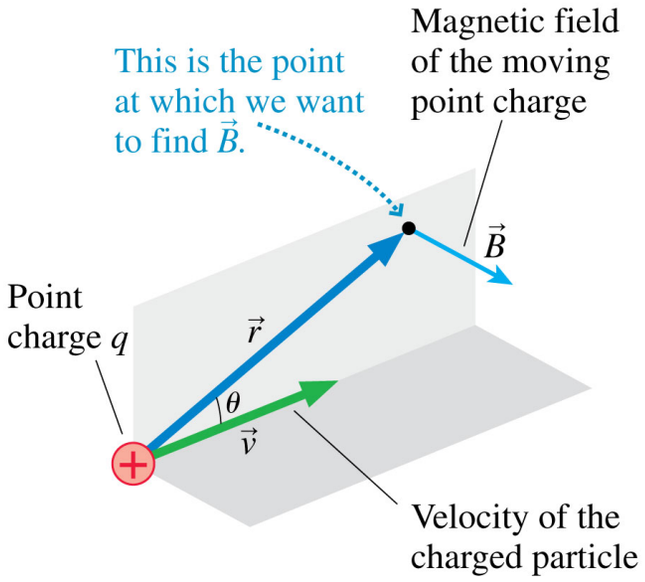
32.3: The Source of the *B*-Field: Moving Charges

Biot-Savart law:

The *magnetic field* of a charged particle q moving with velocity v is given by:

Magnitude:

$$B_q = \frac{\mu_0}{4\pi}\frac{qv\sin\theta}{r^2}$$



Direction:

given by the right-hand rule.

32.3:
The Source of the *B*-Field: Moving Charges

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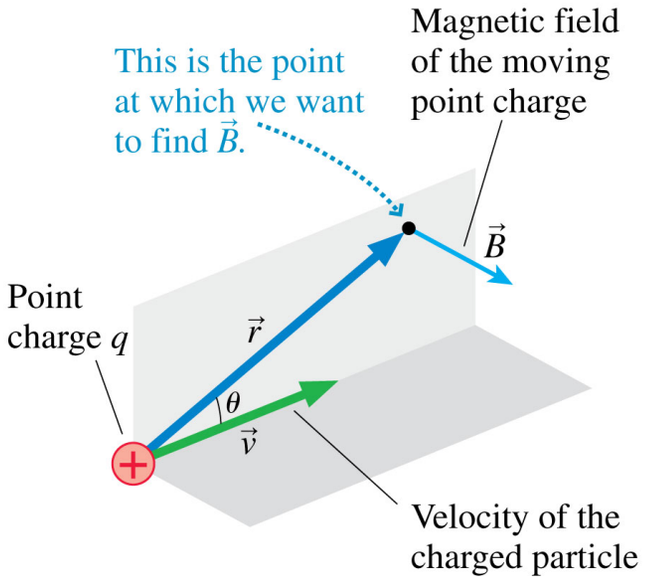

SI Units?

$$[B] = T$$

The *permeability* constant:

$$\mu_0 = 4\pi \times 10^{-7}\mathrm{Tm/A}$$